ACTIVE LIST OF PERMISSIBLE EXPLOSIVES AND BLASTING DEVICES APPROVED BEFORE DECEMBER 31, 1951

BY N. E. **HANNA** AND G. H. **DAMON**

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INTRODUCTION

To be authorized for use in coal mines, explosives and blasting devices must pass certain safety tests prescribed in schedule 1F,[3] on the basis of extensive practical and theoretical research by the Explosives Testing Station of the Federal Bureau of Mines.

An explosive or blasting device that passes these tests is placed on the active permissible list. As this list is constantly revised, it has been the practice of the Bureau of Mines periodically to publish the names of explosives and blasting devices that have been added to the active list, as well as those that have been transferred to the inactive list; changes in brand names also are reported.

This circular covers all permissibles including additions, transfers, and changes made between December 31, 1945,[4] and December 31, 1951.

PERMISSIBLE EXPLOSIVES TESTED UNDER SCHEDULE 1F

The term "permissible explosive" as applied by the Bureau of Mines means not only that the explosive used is similar in all respects to the basic sample that passed all the scheduled tests required for admission to the permissible list but that when used in blasting coal it be used in the permissible manner prescribed.[5] For a permissible explosive to continue to be permissible, it must not only be so manufactured and packed as to possess in kind and degree all the chemical and physical characteristics displayed by the basic sample on which permissibility was determined, but, after it enters commerce and reaches the ultimate consumer, it must at all times be so handled, transported, and stored as to retain these characteristics. Explosives should be obtained in fresh condition and purchased in quantities permitting their prompt use.

Types of Explosives

In listing permissibles, a distinction has been made between gelatinous and nongelatinous explosives. Nongelatinous explosives, which head the list, are well-adapted for use in mines that are relatively dry. The time of exposure to very damp atmospheres should be kept at a minimum because these explosives may deteriorate by absorptional moisture and fail to detonate completely. The gelatin types have been grouped together at the end of the list. These explosives are designed especially for blasting rock in coal mines, although under certain conditions they have been found suitable for shooting coal. They are eminently adapted for use in wet work. Their rates of detonation range from 2,000 to 5,100 meters per second. Because of their high density, more energy may be charged in the same volume.

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[3] Bureau of Mines, Procedure for Testing Explosives (including sheathed explosives) and Blasting Devices for Permissibility and Suitability: Bureau of Mines Schedule 1F. Approved Jan. 20, 1945, 11 pp. Amendments to Schedule 1F were approved Mar. 14, and Aug. 7, 1945, Feb. 27 and Sept. 3, 1948.

[4] Tiffany, J. E., and Gaugler, Z. C., Active List of Permissible Explosives and Blasting Devices Approved Previous to December 31, 1945: Bureau of Mines Rept. of Investigations 3910, 1946, 20 pp.

[5] For detailed specifications, see Appendix I.

Classification on Basis of Poisonous Gases Liberated

All permissible explosives when detonated emit some poisonous gases and a much larger volume of nonpoisonous gases. In order that the poisonous gases may not under normal conditions become a menace to the life or health of miners, no explosive is now or can become permissible if upon detonation it evolves more than 106 liters of poisonous gases per 1-1/2-pound charge, as determined by tests in the Bichel pressure gage.

Classification on the basis of the volume of poisonous gases produced by 680 grams (1-1/2 pounds) of explosive is as follows: Class A, not more than 53 liters; class B, between 53 and 106 liters.6/

Current Active List of Permissible Explosives

The previous active list of permissible explosives, published in July 1946, included 178 brands. Changes in the list, authorized to December 31, 1951, have added 42 brand names to the active permissible list as a result of tests on new explosives, transfers from the inactive list, and changes in brand name. As a result of these changes, the following explosives now are included in the active permissible list:

Alton No. 7	Transferred from inactive list.
American 4-A	By test.
American 21	By change in name.
American A	By test.
Austin Red Diamond No. 1	By change in name.
Austin Red Diamond No. 2	Do.
Austin Red Diamond No. 3	Do.
Austin Red Diamond No. 4	Do.
Austin Red Diamond No. 4, L. F.	Transferred from inactive list.
Austin Red Diamond No. 9-B	By change in name.
Austin Red Diamond No. 9-C	Do.
Austin Red Diamond No. 10-A	Do.
Austin Red Diamond No. 11	Do.
Black Diamond No. 7-AA	By test.
Black Diamond No. 9-A	Do.
Coalite C-1	Do.
Coalite J	By change in name.
Coalite 5-P	By test.
Coalite 5-S	Do.
Coalite 6-P	Do.
Coalite 7-R	Do.
Coalite 7-S	Do.
EL-446	Do.
EL-447	Do.
EL-454	Do.
EP-129	Do.
EP-131	Do.
King No. 7	Transferred from inactive list.
King No. 7-AA	By change in name.
King A	Transferred from inactive list.

6/ A third group known as class C has been eliminated by agreement between the Bureau of Mines and the Institute of Makers of Explosives.

Liberty No. 7	Transferred from inactive list.
National A-1	By test.
Red Crown B-3	Do.
Red HA	By change in name.
Red HL	Do.
U. S. A.	Transferred from inactive list.
Gel-Coalite No. 3	Do.
Gelobel AA	By test.
Permigel 2	Transferred from inactive list.
Permigel 4	By test.
Permigel A	Do.
Permigel B	Do.

Forty-six permissible explosives were transferred from the active to the inactive list:

Alton No. 3
American 3
American 4
American 14
American 24
American 25
American 26
American 112
Apcol No. 3
Apcol No. 3-B
Bituminite F
Austin Red Diamond No. 1, L. F.
Austin Red Diamond No. 2, L. F.
Austin Red Diamond No. 3, L. F.
Austin Red Diamond No. 4, L. F.
Austin Red Diamond No. 9-B, L. F.
Austin Red Diamond No. 9-C, L. F.
Austin Red Diamond No. 10-A, L. F.
Austin Red Diamond No. 11, L. F.
Burton A
Trojan Coal Powder M-3
Trojan Coal Powder M-5
Trojan Coal Powder M-6
Coalite J
Columbia 2
Duobel G
EP-129
EP-131
Genite A
Hercoal C-1
Hercoal D
Hercoal F-1
Hercules Coal Powder 2
Liberty No. 1
Monobel No. 9, L. F.
Permigel 1
Permigel 2
Permigel 2-A
Permigel 3
Permigel 4
Red H No. 4
Red H No. 5
Trojan Coal Powder M-2
Trojan Coal Powder P-1
Trojan Coal Powder P-2
Trojan Coal Powder P-3

The current list of permissible explosives includes 174 different brands, of which about 25 are of the gelatinous type and the remainder of the more commonly used granular ammonium nitrate type. This wide selection of permissibles offers the industry a most generous range of physical characteristics to meet the diversified needs of mining. Their rates of detonation range from 1,500 to 5,100 meters per second. About 10 percent of the permissibles listed have rates of detonation below 2,000 meters per second, 50 percent are between 2,000 and 3,000 meters per second, and the remainder are over 3,000 meters per second. In weight per 1-1/4- by 8-inch cartridge, there is a variation of from 86 to 244 grams, giving a stick count of from 264 to 93 per 50 pound box. Most of the permissible explosives are available in cartridge sizes from 1 to 2-1/2 inches in diameter and several brands are available in diameters as large as 3 inches. Cartridge diameters under 1 inch are rarely used and have been eliminated in accordance with an agreement between the Bureau of Mines and the Institute of Makers of Explosives. A No. 6 electric detonator was used in testing all explosives now on the active permissible list; no detonator of less efficiency is authorized for firing permissible explosives in coal mines.

The complete active list of permissible explosives is given in the following table:

Permissible explosives as of December 31, 1951

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases[1]	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Smallest permissible diameter	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer[2]
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches		±		±	
Alton No. 7[3]	A	177	128	1	7,900	1,300	2,400	400	Equitable.
Alton No. 8	A	129	176	1	7,500	1,000	2,300	300	Do.
Alton No. 9	A	114	199	1	5,600	1,000	1,700	300	Do.
American 1	A	160	142	1	5,900	1,000	1,800	300	American.
American 2	A	143	159	1	7,200	1,000	2,200	300	Do.
American 3-A	B	125	182	1	6,900	1,000	2,100	300	Do.
American 4-A	B	109	208	1	7,200	1,000	2,200	300	Do.
American 5	B	107	212	1	6,600	1,000	2,000	300	Do.
American 11	A	159	143	1	8,200	1,300	2,500	400	Do.
American 12	B	143	159	1	8,200	1,300	2,500	400	Do.
American 12-A	A	134	169	1	7,500	1,000	2,300	300	Do.
American 14-A	B	110	206	1	7,200	1,000	2,200	300	Do.
American 21[4]	A	163	139	1	11,200	1,600	3,400	500	Do.
American 22	A	143	159	1	10,500	1,600	3,200	500	Do.
American 23	B	124	183	1	9,200	1,300	2,800	400	Do.
American A	A	185	123	1	9,500	1,300	2,900	400	Do.
Apache Coal Powder A	B	137	166	1-1/4	11,800	1,600	3,600	500	Apache.
Apache Coal Powder B	B	158	144	1-1/4	8,200	1,300	2,500	400	Do.
Apache Coal Powder H, L.F.	A	164	138	1-1/8	10,800	1,600	3,300	500	Do.
Apcol No. 1	A	175	130	1	7,500	1,000	2,300	300	Atlas
Apcol No. 1-B	A	175	130	1-1/4	7,200	1,000	2,200	300	Do.
Austin Red Diamond No. 1[5]	B	173	131	1	10,500	1,600	3,200	500	Austin
Austin Red Diamond No. 2[6]	A	134	169	1-1/4	6,900	1,000	2,100	300	Do.
Austin Red Diamond No. 3[7]	A	160	142	1-1/8	6,900	1,000	2,100	300	Do.
Austin Red Diamond No. 4[8]	A	191	119	1	9,800	1,300	3,000	400	Austin
Austin Red Diamond No. 9-B[9]	B	133	171	1	7,500	1,000	2,300	300	Do.
Austin Red Diamond No. 9-C[10]	B	144	158	1	8,500	1,300	2,600	400	Do.
Austin Red Diamond No. 10-A[11]	B	123	185	1	8,200	1,300	2,500	400	Do.
Austin Red Diamond No. 11[12,13]	B	101	225	1	7,200	1,000	2,200	300	Do.
Big Coal D	A	162	140	1	5,900	1,000	1,800	300	Liberty.
Big Red No. 7-C	A	160	142	1	9,200	1,300	2,800	400	Equitable.
Bituminite D	A	138	164	1-1/4	5,900	1,000	1,800	300	Hercules.
Black Diamond No. 5-A	A	163	139	1	9,500	1,300	2,900	400	Illinois.
Black Diamond No. 7	A	183	124	1	10,800	1,600	3,300	500	Do.
Black Diamond No. 7-A	B	155	146	1	11,500	1,600	3,500	500	Do.
Black Diamond No. 7-AA ...	A	156	146	1	10,800	1,600	3,300	500	Do.
Black Diamond No. 8	A	134	169	1	7,500	1,000	2,300	300	Do.
Black Diamond No. 9	B	144	158	1	8,500	1,300	2,600	400	Do.
Black Diamond No. 9-A	A	147	154	1	7,900	1,300	2,400	400	Do.
Black Diamond No. 11	B	123	185	1	8,900	1,300	2,700	400	Do.

1/ Classification upon basis of volume of poisonous gases produced given on p. 2.
2/ For complete name and address of manufacturer, see Appendix II.
3/ Transferred from inactive list.
4/ Formerly listed as Genite A.
5/ Formerly listed as Austin Red Diamond No. 1, L. F.
6/ Formerly listed as Austin Red Diamond No. 2, L. F.
7/ Formerly listed as Austin Red Diamond No. 3, L. F.
8/ Formerly listed as Austin Red Diamond No. 4, L. F.
9/ Formerly listed as Austin Red Diamond No. 9-B, L. F.
10/ Formerly listed as Austin Red Diamond No. 9-C, L. F.
11/ Formerly listed as Austin Red Diamond No. 10-A, L. F.
12/ Formerly listed as Austin Red Diamond No. 11, L. F.
13/ New basic data.

Permissible explosives as of December 31, 1951 (Cont.)

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases[1]	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Smallest permissible diameter	Rate of detonation in 1-1/4-inch diameter cartridge: Feet per second, Average	Feet per second, Allowable variation	Meters per second, Average	Meters per second, Allowable variation	Manufacturer[2]
1	2	3	4	5	6				7
		Grams		Inches		±		±	
Black Diamond No. 11-A ...	B	111	205	1	10,200	1,600	3,100	500	Illinois.
Black Diamond No. 11-B ...	A	115	197	1	7,200	1,000	2,200	300	Do.
Black Diamond No. 12-B ...	B	105	216	1-1/8	7,900	1,300	2,400	400	Do.
Black Diamond No. 15	A	160	142	1	6,600	1,000	2,000	300	Do.
Black Diamond No. 55	A	208	109	1	11,200	1,600	3,400	500	Do.
Black Diamond A	A	194	117	1	8,500	1,300	2,600	400	Do.
Black Diamond G	B	90	252	1-1/8	8,500	1,300	2,600	400	Do.
Black Diamond Special A ..	A	169	134	1-1/4	4,900	700	1,500	200	Do.
Black Diamond Special C ..	A	138	164	1-1/4	5,900	1,000	1,800	300	Do.
Coalite B	B	138	164	1	11,500	1,600	3,500	500	Atlas
Coalite C	A	168	135	1	12,100	2,000	3,700	600	Do.
Coalite C-1	A	166	137	1	11,800	1,600	3,600	500	Do.
Coalite E	A	168	135	1	6,200	1,000	1,900	300	Do.
Coalite G	A	152	149	1	7,900	1,300	2,400	400	Do.
Coalite G-1	A	153	148	1-1/8	7,200	1,000	2,200	300	Do.
Coalite K	B	101	225	1	9,500	1,300	2,900	400	Do.
Coalite K-1	B	101	225	1-1/8	9,200	1,300	2,800	400	Do.
Coalite L	A	111	205	1	8,900	1,300	2,700	400	Do.
Coalite L-1	A	111	205	1-1/8	8,900	1,300	2,700	400	Do.
Coalite LS	B	103	220	1	6,200	1,000	1,900	300	Do.
Coalite LS-1	B	103	220	1-1/8	6,600	1,000	2,000	300	Do.
Coalite M	B	124	183	1	9,500	1,300	2,900	400	Do.
Coalite M-1	A	123	185	1-1/4	9,500	1,300	2,900	400	Do.
Coalite MS	B	119	191	1-1/8	6,200	1,000	1,900	300	Do.
Coalite MS-1	A	119	191	1-1/8	6,600	1,000	2,000	300	Do.
Coalite O	B	92	247	1	7,500	1,000	2,300	300	Do.
Coalite S	B	138	164	1	7,900	1,300	2,400	400	Do.
Coalite S-1	A	138	164	1-1/4	7,900	1,300	2,400	400	Do.
Coalite T	A	139	163	1	5,900	1,000	1,800	300	Do.
Coalite T-1	A	134	169	1-1/8	5,900	1,000	1,800	300	Do.
Coalite 5-P	A	168	135	1-1/4	5,200	700	1,600	200	Do.
Coalite 5-S	A	168	135	1-1/4	5,200	700	1,600	200	Do.
Coalite 6-P	A	177	128	1-1/8	8,900	1,300	2,700	400	Do.
Coalite 7-R	A	191	119	1	8,500	1,300	2,600	400	Do.
Coalite 7-S	A	189	120	1	10,500	1,600	3,200	500	Do.
Collier C	A	141	161	1	11,800	1,600	3,600	500	Hercules.
Columbia A	A	162	140	1	5,900	1,000	1,800	300	Columbia.
Columbia B	A	177	128	1	7,900	1,300	2,400	400	Do.
Columbia B-2	A	160	142	1	9,200	1,300	2,800	400	Do.
Columbia C	A	150	151	1	8,200	1,300	2,500	400	Do.
Columbia C-1	A	151	150	1	8,500	1,300	2,600	400	Do.
Columbia D	A	142	160	1	7,500	1,000	2,300	300	Do.
Columbia E	A	129	176	1	7,500	1,000	2,300	300	Do.
Columbia F	A	116	196	1	8,900	1,300	2,700	400	Do.
Columbia G	A	114	199	1	5,600	1,000	1,700	300	Do.
Columbia 3	A	134	169	1	11,200	1,600	3,400	500	Do.
Columbia 4	A	186	122	1	9,800	1,300	3,000	400	Do.
Duobel A	A	168	135	1	10,500	1,600	3,200	500	du Pont.
Duobel B	A	150	151	1	9,800	1,300	3,000	400	Do.
Duobel C	A	143	159	1	9,800	1,300	3,000	400	Do.
Duobel D	A	124	183	1	10,200	1,600	3,100	500	Do.
Duobel E	A	112	203	1	10,800	1,600	3,300	500	Do.
Duobel F	B	99	229	1	9,200	1,300	2,800	400	Do.
EL-446	A	188	121	1	9,200	1,300	2,800	400	Do.
EL-447	A	188	121	1	9,200	1,300	2,800	400	Do.
EL-454	A	190	119	1-1/4	8,500	1,300	2,600	400	Do.

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[1] Classification upon basis of volume of poisonous gases produced given on p. 2.

[2] For complete name and address of manufacturer, see Appendix II.

Permissible explosives as of December 31, 1951 (Cont.)

NONGELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases[1]	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Smallest permissible diameter	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer[2]
					Feet per second		Meters per second		
					Average	Allowable variation	Average	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches		±		±	
Independent A	A	143	159	1-1/8	7,900	1,300	2,400	400	Independent.
Independent B	B	98	232	1-1/4	6,600	1,000	2,000	300	Do.
Independent C	A	112	203	1-1/4	6,600	1,000	2,000	300	Do.
Independent D	A	127	179	1-1/4	6,600	1,000	2,000	300	Do.
Independent E	A	179	127	1-1/4	7,500	1,000	2,300	300	Do.
Independent F	A	136	167	1-1/4	8,900	1,300	2,700	400	Do.
Independent G	B	100	227	1-1/4	7,900	1,300	2,400	400	Do.
Independent H	A	120	189	1-1/4	8,500	1,300	2,600	400	Do.
King No. 7[3]	A	183	124	1	10,800	1,600	3,300	500	King.
King No. 7-A	B	155	146	1	11,500	1,600	3,500	500	Do.
King No. 7-AA[14]	A	156	146	1	10,800	1,600	3,300	500	Do.
King No. 15	A	160	142	1	6,600	1,000	2,000	300	Do.
King A[3]	A	194	117	1	8,500	1,300	2,600	400	Do.
Liberty No. 2	A	134	169	1	11,200	1,600	3,400	500	Liberty.
Liberty No. 2-A	A	142	160	1	7,500	1,000	2,300	300	Do.
Liberty No. 3	A	150	151	1	8,200	1,300	2,500	400	Do.
Liberty No. 3-A	A	151	150	1	8,500	1,300	2,600	400	Do.
Liberty No. 5	A	186	122	1	9,800	1,300	3,000	400	Do.
Liberty No. 7[3]	A	177	128	1	7,900	1,300	2,400	400	Do.
Liberty No. 8	A	129	176	1	7,500	1,000	2,300	300	Do.
Liberty No. 9	A	114	199	1	5,600	1,000	1,700	300	Do.
Liberty No. 11	B	86	264	1	7,200	1,000	2,200	300	Do.
Lump Coal C	A	137	166	1-1/4	5,900	1,000	1,800	300	du Pont.
Lump Coal CC	A	136	167	1-1/8	6,900	1,000	2,100	300	Do.
Miners' Friend No. 2	B	166	137	1	10,500	1,600	3,200	500	Atlas
Monobel AA	A	190	119	1	7,900	1,300	2,400	400	du Pont.
Monobel A	A	169	134	1	8,200	1,300	2,500	400	Do.
Monobel B	A	150	151	1	8,500	1,300	2,600	400	Do.
Monobel C	A	137	166	1	8,200	1,300	2,500	400	Do.
Monobel D	B	123	185	1	8,200	1,300	2,500	400	Do.
Monobel E	B	111	205	1	8,200	1,300	2,500	400	Do.
National A	A	160	142	1	8,500	1,300	2,600	400	National.
National A-1	A	183	124	1-1/8	10,500	1,600	3,200	500	Do.
National B	A	147	154	1	10,500	1,600	3,200	500	Do.
National C	B	100	227	1	8,900	1,300	2,700	400	Do.
National D	A	162	140	1	6,900	1,000	2,100	300	Do.
National E	A	143	159	1-1/8	7,900	1,300	2,400	400	Do.
National F	B	98	232	1-1/4	6,600	1,000	2,000	300	Do.
National F-1	B	90	252	1-1/8	8,500	1,300	2,600	400	Do.
National G	A	112	203	1-1/4	6,600	1,000	2,000	300	Do.
National H	A	127	179	1-1/4	6,600	1,000	2,000	300	Do.
Red Crown B-3	A	155	146	1-1/4	8,200	1,300	2,500	400	King.
Red Crown D-2	A	128	177	1-1/4	6,200	1,000	1,900	300	Do.
Red HA[15]	A	190	119	1	9,500	1,300	2,900	400	Hercules.
Red HB	A	155	146	1	12,100	2,000	3,700	600	Do.
Red HC	A	168	135	1	5,900	1,000	1,800	300	Do.
Red HD	A	150	151	1	7,900	1,300	2,400	400	Do.
Red HF	A	128	177	1	7,500	1,000	2,300	300	Do.
Red HL[16]	A	119	191	1	8,200	1,300	2,500	400	Do.
U. S. No. 15	A	160	142	1	6,600	1,000	2,000	300	United.
U. S. A[3]	A	194	117	1	8,500	1,300	2,600	400	Do.
U. S. G	B	90	252	1-1/8	8,500	1,300	2,600	400	Do.
U. S. Special C	A	138	164	1-1/4	5,900	1,000	1,800	300	Do.
Wesco Coal Powder No. 1...	A	175	130	1-1/4	9,200	1,300	2,800	400	West.

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[1] Classification upon basis of poisonous gases produced given on p. 2.

[2] For complete name and address of manufacturer, see Appendix II.

[3] Transferred from inactive list.

[14] Same as Black Diamond No. 7-AA.

[15] Same as EP-129.

[16] Same as EP-131.

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Permissible explosives as of December 31, 1951 (Cont.)

GELATINOUS PERMISSIBLE EXPLOSIVES

Brand	Class designation basis, volume of poisonous gases[1]	Weight of 1-1/4- by 8-inch cartridge	Number of 1-1/4- by 8-inch cartridges in 50-lb. case	Smallest permissible diameter	Rate of detonation in 1-1/4-inch diameter cartridge				Manufacturer[2]
					Feet per second		Meters per second		
					Average	Allowable variation	Average[17]	Allowable variation	
1	2	3	4	5	6				7
		Grams		Inches		±		±	
Alton-Gel B	A	227	100	1	14,800	2,300	4,500	700	Equitable.
Alton-Gel C	A	171	133	1	10,200	1,600	3,100	500	Do.
Austin Red-D-Gel	A	244	93	1	14,800	2,300	4,500	700	Austin.
Black Diamond Nu-Gel No. 4	A	193	118	1	13,400	2,000	4,100	600	Illinois.
Columbia-Gel 1	A	226	100	1	13,800	2,000	4,200	600	Columbia.
Columbia-Gel 2	A	171	133	1	10,200	1,600	3,100	500	Do.
Columbia-Gel 3	A	227	100	1	14,800	2,300	4,500	700	Do.
Gel-Coalite W	A	189	120	1	12,500	2,000	3,800	600	Atlas.
Gel-Coalite X	A	239	95	1	9,500	1,300	2,900	400	Do.
Gel-Coalite Z	A	226	100	1	16,700	2,600	5,100	800	Do.
Gel-Coalite No. 3[3]	A	183	124	1	11,500	1,600	3,500	500	Do.
Gelobel A	A	220	103	1	15,700	2,300	4,800	700	du Pont.
Gelobel AA	A	215	106	1	15,000	2,300	4,700	700	Do.
Gelobel B	A	202	112	1	8,900	1,300	2,700	400	Do.
Gelobel C	A	190	119	1	13,400	2,000	4,100	600	Do.
Hercogel 2	A	186	122	1	11,800	1,600	3,600	500	Hercules.
Hercogel A	A	220	103	1	14,800	2,300	4,500	700	Do.
Independent Gel-A	A	244	93	1	14,800	2,300	4,500	700	Independent.
Liberty-Gel, L. F.	A	226	100	1	13,800	2,000	4,200	600	Liberty.
Liberty-Gel A	A	227	100	1	14,800	2,300	4,500	700	Do.
Liberty-Gel B	A	171	133	1	10,200	1,600	3,100	500	Do.
Napcogel No. 1	A	216	105	1-1/8	14,800	2,300	4,500	700	National.
Permigel A	A	218	104	1	11,500	1,600	3,500	500	American.
Permigel B	A	189	120	1	13,400	2,000	4,100	600	Do.

[1] Classification upon basis of volume of poisonous gases produced given on p. 4.

[2] For complete name and address of manufacturer, see Appendix II.

[3] Transferred from the inactive list.

[17] Rate of detonation of gelatinous permissible explosives may be low (approximately 2,000 m./sec.), high (approximately 5,000 m./sec.), or intermediate. However, it is believed that in a borehole all of these explosives will develop rates close to the high rate.

PERMISSIBLE BLASTING DEVICES TESTED UNDER SCHEDULE 1F

The active list of permissible blasting devices, approved before December 31, 1951, shows no additions or changes from the list published in 1946.[7]

The Cardox permissible-blasting device consists of a thick-walled steel tube closed at one end by a plug equipped with electrical connections and at the other end by a replaceable steel disk held in place by a discharge head. There are nine models on the approved list, all of which use liquid carbon dioxide as a blasting agent and a heater element consisting of potassium perchlorate and coal. The shell is assembled and charged on the surface outside the mine.

The combustion of the heater element, which is initiated electrically through a medium of a permissible blasting unit and an igniter of the match-head type, liberates enough energy to completely gasify the liquid carbon dioxide within the shell. When the internal pressure reaches a predetermined value, the steel disk ruptures and allows a sudden escape of the gases through ports in the discharge head with enough force to break down the coal. Permissibility of the Cardox devices was established by gallery tests similar to those used for explosives. In these tests the shell was discharged into gas and air, or gas, coal-dust, and air mixtures without igniting them. The conditions of charging the shell, such as the weights of carbon dioxide charge, heater element ingredients and the thickness of the disk, were varied according to the conditions under which these devices might be used in blasting coal.[8]

The complete active list of permissible blasting devices, as of December 31, 1951, is shown in the following table; the maximum permissible weight of heater ingredient for a given thickness of disk also is shown for each shell.

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[7] Work cited in footnote 2.

[8] For additional requirements relating to permissible blasting devices, see Appendix III.

Permissible Cardox models, as of December 31, 1951, manufactured by Cardox Corp., Chicago, Ill.

Number of		Dimension of shell				Authorized combinations			
		Length		Diameter		Shear opening in discharge cap, diameter	Heater, maximum weight of ingredient (potassium perchlorate-coal mixture)	Disk (sheet metal)	
Approval	Extension	Cm.	In.	Cm.	In.	In.	Grams	Minimum gage	Minimum shearing pressure per sq. in., thousands of pounds[1]
			CARDOX MODEL B-20						
			Usual charge of carbon dioxide 255 grams[2]						
7 and 18	1 and 2	60.7	23-7/8	4.4	1-3/4	7/8	35	12	18
						7/8	45	10	23
			CARDOX MODEL B-37						
			Usual charge of carbon dioxide 450 grams[2]						
6 and 18	2 and 3	103.2	40-5/8	4.4	1-3/4	7/8	80	12	18
						7/8	100	10	23
			CARDOX MODEL B-44						
			Usual charge of carbon dioxide 570 grams[2]						
8 and 18	2 and 3	118.4	46-5/8	4.4	1-3/4	7/8	80	12	18
						7/8	100	10	23
			CARDOX MODEL D-100						
			Usual charge of carbon dioxide 1,425 grams[2]						
5 and 18	3 and 4	118.1	46-1/2	6.4	2-1/2	1-7/16	180	[3]10	17
			CARDOX MODEL 2-50						
			Usual charge of carbon dioxide 675 grams[2]						
18		88	34-5/8	5.1	2	1-1/16	80	12	13
						1-1/16	100	10	17
			CARDOX MODEL 2-80						
			Usual charge of carbon dioxide 1,075 grams[2]						
18		118.4	46-5/8	5.1	2	1-1/16	100	12	13
						1-1/16	110	10	17
			CARDOX MODEL 2-100						
			Usual charge of carbon dioxide, 1,425 grams[2]						
18		148.9	58-5/8	5.1	2	1-1/16	110	12	13
						1-1/16	110	10	17
			CARDOX MODEL 231-130						
			Usual charge of carbon dioxide, 1,800 grams[2]						
18		151.4	59-5/8	5.9	2-5/16	1-3/8	130	[3]12	12
						1-3/8	160	[3]10	16
			CARDOX MODEL 3-200						
			Usual charge of carbon dioxide 2,800 grams[2]						
18		134.0	52-3/4	7.6	3	1-3/4	200	[3]12	10
						1-3/4	200	[3]10	13

[1] Minimum shearing pressures allow a reasonable tolerance from those actually determined by tests.

[2] Maximum weight of heater and minimum disk gage are combinations for the usual charge of carbon dioxide as stated for each model. Combinations studied and tested at the gallery were with low charges of carbon dioxide. Therefore, a charge of carbon dioxide less than that usually used does not affect the permissible use of the device.

[3] Strip-steel disks instead of sheet metal.

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APPENDIX I: GENERAL REQUIREMENTS FOR PERMISSIBLE EXPLOSIVES

It is provided further:

That, in accordance with the provisions and conditions, explosives enumerated on the permissible lists of the Bureau of Mines are permissible in use only when they satisfy the following requirements:

1. That the explosive conforms with the basic sample submitted by the manufacturer for tests, within limits of tolerance prescribed by the Bureau of Mines, and that the diameters of the cartridges used be those that have been approved;

2. That electric detonators (not fuse and detonators) used be not less in efficiency than No. 6, the detonating charge of which shall consist of a 1-gram mixture of 80 parts of mercury fulminate and 20 parts of potassium chlorate (or their equivalents), and that the required electric firing be done by means of a permissible-type blasting unit;

3. That the explosive be stored in surface magazines under conditions such that it shall not undergo change in character; once underground the explosive is to be used in less than 36 hours;

4. That the coal to be blasted be undercut or equivalently relieved; that, to prevent blow-throughs, all portions of the borehole be at least 18 inches from relief in any direction; that, to prevent blow-outs, the charge be properly confined with not less than 2 feet of clay[9] or other incombustible stemming or any stemming device approved by the Bureau of Mines, and not be on the solid; that, to prevent the hole from being on the solid, it shall be at least 6 inches shorter than the depth of the undercut or equivalent relief, and, when placed adjacent to the roof, ribs, or floor, all but 12 inches at the rear of the hole shall be at least 6 inches from the adjacent surface as projected into the coal to be blasted, and all parts of the hole shall be free from the adjacent surface as projected into the coal to be blasted; that the shot be not a dependent shot; and that the shot hole be cleaned before charging;

5. That the blasting region be kept well protected by rock dust, or otherwise, in accordance with Bureau of Mines inspection standards;

6. That the shot be not fired in the presence of a dangerous percentage of firedamp and that examination for firedamp be made at the blasting area, before and after shooting in a gassy mine.

7. That the quantity used for a shot (a) does not exceed 680 grams (1-1/2 pounds) when fired in accordance with these requirements, or (b) does not exceed 1,361 grams (3 pounds) when fired in accordance with the following additional requirements:

   (a) Shot holes must be 6 feet or greater in length.

   (b) Explosives must be charged in a continuous train with no cartridges deformed or crushed, with all cartridges in contact with each other, and with the end cartridge touching the rear of the hole and the stemming, respectively.

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[9] If the length of the hole will not permit the charge desired and 2 feet of stemming, at least half the length of the hole shall be filled with stemming.

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APPENDIX II: NAMES AND ADDRESSES OF MANUFACTURERS LISTED

American: American Cyanamid Co., New York, N. Y.

Apache: Apache Powder Co., Benson, Ariz.

Atlas: Atlas Powder Co., Wilmington, Del.

Austin: Austin Powder Co., Cleveland, Ohio.

Columbia: Columbia Powder Co., Tacoma, Wash.

du Pont: E. I. du Pont de Nemours & Co., Wilmington, Del.

Equitable: Equitable Powder Manufacturing Co., East Alton, Ill.

Hercules: Hercules Powder Co., Wilmington, Del.

Illinois: Illinois Powder Manufacturing Co., St. Louis, Mo.

Independent: Independent Explosives Co., Scranton, Pa.

King: King Powder Co., Inc., Cincinnati, Ohio

Liberty: Liberty Powder Co., Division of Olin Corp., Pittsburgh, Pa.

National: National Powder Co., Eldred, Pa.

United: United States Powder Co., Terre Haute, Ind.

West: West Coast Powder Co., Everett, Wash.

APPENDIX III: GENERAL REQUIREMENTS FOR PERMISSIBLE BLASTING DEVICES

It is provided further:

That, in accordance with the provisions and conditions, the devices enumerated on the permissible list of the Bureau of Mines are permissible in use only when they satisfy the following requirements:

1. The device must conform with the basic sample;

2. The conditions of charging as approved by the Bureau of Mines must be met;

3. The wires of the firing line must not be connected to the shell until the device has been placed in the borehole;

4. The device must not be fired in the presence of a dangerous percentage of firedamp. The shot must be fired with a permissible-type blasting unit;

5. The device cannot be fired until all personnel are 100 feet or more from the shot and protected by adequate cover, having one or, if possible, two right angles between them and the blast;

6. The device must not be charged with the heater ingredient and carbon dioxide in the mine;

7. The coal to be blasted must be undercut or equivalently relieved; the length of the shot hole should be at least 6 inches less than the depth of the undercut or equivalent relief; and that the shot hole should be at least 6 inches away from the side of the undercut or equivalent relief.

Int. - Bu. of Mines, Pgh., Pa.